WIDE INPUT VOLTAGE RANGE LIGHT EMITTING DIODE DRIVER

FIELD OF THE INVENTION

[001] The present invention relates in general to communication circuits and the like, and is particularly directed to a new and improved indicator circuit, specifically, a current-regulating driver circuit for a light emitting diode (LED), which is operative to maintain the energization drive to and thereby the illumination provided by the LED at a prescribed, substantially constant value, over a relatively wide range of input (AC or DC) voltage.

BACKGROUND OF THE INVENTION

[002] Electronic circuits often employ light emitting diodes (LEDs) to indicate the presence of an operational voltage or electrical power. In a typical application, the LED will be coupled in parallel with the load that is consuming electrical power. In order to operate within specified parameters, LEDs require a relatively narrow range of direct current and voltage. As a result, to use an LED as an indicator, it is customary practice

to employ a series, current-limiting resistor that sets the operational parameters for the LED for a given application. A shortcoming of this approach is that a different valued resistor must be selected for each application. This limits the utility of a given driver circuit; moreover, the voltage must be a DC voltage of the proper polarity. It does not allow the same LED driver circuit to be used in the presence of a widely varying input voltage, nor does it allow for either AC or DC voltage.

SUMMARY OF THE INVENTION

[003] In accordance with the present invention, shortcomings of conventional LED driver circuits, including those referenced above, are effectively obviated by a current-regulating driver circuit for a light emitting diode (LED), which is operative to maintain the energization drive to and thereby the illumination provided by the LED at a prescribed, substantially constant value, over a relatively wide range of input (AC or DC) voltage. To this end, the circuit architecture of the light-emitting diode (LED) circuit of the present invention comprises a pair of input/output nodes through which a voltage source, which may comprise either an AC or a DC voltage source, is coupled to a load. A first of the input/output nodes is coupled through an input rectifying diode to each of a first, series limiting resistor and to the collector of an LED current supply transistor. The input diode serves

to allow current to pass through the circuit in only one direction and allows the invention to be employed with an AC voltage source, a DC voltage source of the correct polarity, or both.

[004] The limiting resistor has a value that sets the input bias current of the LED current supply transistor. The LED current supply transistor has its base coupled to a second end of the limiting resistor, which is also coupled to the collector of a current sense transistor. This current sense transistor is adapted to pass a collector current that is larger than the base bias current for the LED current supply transistor, so as to regulate the current flow through the LED. The LED current supply transistor has its emitter coupled to a light emitting diode which is coupled to the base of the current sense transistor and to a second, current sense resistor. The second resistor and the emitter of the current sense emitter of transistor are coupled to the second input/output node. The current sense resistor is used to set the current through the LED and, at the same time, just turns on the base-emitter junction of the current sense transistor.

[005] In operation, application of either an AC voltage or a DC voltage of the appropriate polarity to the input/output nodes will cause current to flow through the input diode and through the limiting resistor, so as to forward bias the base-emitter junction of the LED supply transistor. This turns on that transistor, causing current to flow from the input diode through the

collector-emitter path of the LED current supply transistor and forward bias the LED, so that the LED turns on.

[006] The current flowing through the collector-emitter path of the LED supply transistor and through the LED also flows through sense resistor to the second input/output node. The resulting voltage drop across the sense resistor is applied to the base-emitter junction of the sense transistor. As current through the path containing the LED supply transistor, the LED and the sense resistor increases, it will eventually reach a point that the voltage drop across the sense resistor will exceed the turn-on voltage of the base-emitter junction of the sense transistor. As the sense transistor turns on, it begins to draw current away from the base of the LED supply transistor, thereby reducing the base bias to the LED supply transistor, and decreasing the current flow through the collector-emitter path of the LED supply transistor. Reducing the current flow through the collector-emitter path of the LED supply transistor also reduces current flow through the LED and the sense resistor. Namely, with respect to the base bias current of the LED supply transistor, the sense resistor and the sense transistor serve to effectively provide current regulation for the LED irrespective so as to accommodate a wide swing the value of the input voltage.

BRIEF DESCRIPTION OF THE DRAWINGS

[007] The single Figure diagrammatically illustrates the overall architecture of the current regulating, light-emitting diode (LED) driver circuit in accordance with the present invention.

DETAILED DESCRIPTION

[008] The overall architecture of the light-emitting diode (LED) circuit in accordance with the present invention is shown diagrammatically in the single Figure of drawings, as comprising respective first and second nodes 11 and 12 through which a voltage source 10, which may comprise either an AC or a DC voltage source, is coupled to a load, shown as a resistive load 30 for purposes of simplification. The LED circuit of the invention is contained in broken lines 20 and comprises an input rectifying diode D1 having its anode coupled to node 11 and its cathode coupled to each of a first end of first, series limiting resistor R1 and to the collector of a first bipolar (NPN), LED current supply transistor Q1. Input diode D1 has a peak inverse breakdown voltage that is higher than the peak operating voltage supplied by source 10 to nodes 11 and 12. Input diode D1 serves to allow current to pass through the circuit in only one direction and allows the invention to be employed with an AC voltage source, a DC voltage source of the correct polarity, or both. Resistor R1 has a value that is selected to set the input bias current of transistor Q1. Current supply transistor is chosen to

have a collector-emitter breakdown voltage that is higher than the applied peak operating voltage.

[009] It is to be understood that although the transistors of circuit 20 are shown as bipolar devices, other functionally equivalent devices, such as field effect transistors, as a non-limiting example, may be alternatively be employed. LED current supply transistor Q1 has its base coupled to a second end of resistor R1, which is coupled to the collector of a second bipolar current sense (NPN) transistor Q2. Current sense transistor is operative to pass a collector current that is larger than the base bias current for transistor Q1. Transistor Q1 has its emitter coupled to the anode of a light emitting diode L1, the cathode of which is coupled to the base of transistor Q2 and to one end of a second, current sense resistor R2. Although only a single LED L1 is illustrated (in order to reduce the complexity of the drawings), it is to be understood that the invention is also applicable to the case where multiple LEDs are connected in series. The second end of resistor R2 and the emitter of transistor Q2 are coupled to node 12. As will be described, the current sense resistor R2 is used to set the current through the LED L1 and, at the same time, just turns on the base-emitter junction of current sense transistor Q2.

[010] The LED circuit of the present invention operates as follows. The application of either an AC voltage source or a DC voltage source of the appropriate voltage polarity to nodes 11 and 12 will cause current to flow

through the input diode D1 and through limiting resistor R1, so as to forward bias the base-emitter junction of transistor Q1. This turns on transistor Q1, causing current from diode D1 to flow through the collector-emitter path of transistor Q1 and forward bias LED L1, so that LED L1 turns on.

[011] The current flowing through the collector-emitter path of transistor Q1 and through LED L1 also flows through sense resistor R2 to node 12. The resulting voltage drop across sense resistor R2 is applied to the base-emitter junction of sense transistor Q2. As current flow through the path containing transistor Q1, LED L1 and sense resistor R2 increases, it will eventually reach a point that the voltage drop across sense resistor R2 will exceed the turn-on voltage of the base-emitter junction of transistor Q2. As it turns on, transistor Q2 begins to draw current away from the base of transistor Q1, thereby reducing the base bias to transistor Q1, and consequently decreasing the current flow through the collector-emitter path of transistor Q1. Reducing the current flow through the collector-emitter path of transistor Q1 also means that current flow through LED L1 and resistor R2 is reduced. Namely, the action of sense resistor R2 and sense transistor Q2 with respect to the base bias current of transistor Q1 serves to effectively regulate the current through the LED L1 over a relatively wide range of input voltage.

[012] While I have shown and described an embodiment in accordance with the present invention, it is to be

understood that the same is not limited thereto but is susceptible to numerous changes and modifications as known to a person skilled in the art, and I therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.